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Optimizing Digital Literacy Through Problem-Based Learning Models to Improve Student's Critical Thinking Skills

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ABSTRACT

Objective: Globalization and rapid technological advancements demand that education evolve to incorporate digital literacy, essential for developing critical thinking skills. This research was conducted to describe the effect of optimizing digital literacy through the PBL model on the critical thinking skills of secondary school students. **Method:** This research used a Classroom Action Research model and was carried out in 3 cycles of four activities: planning, action, observation, and reflection. **Results:** The student's critical thinking skills significantly improved throughout PBL implementation. PBL encourages students to be active in solving real problems and allows them to apply digital literacy optimally. The strong correlation between digital literacy and critical thinking skills shows that both complement each other in evaluating and utilizing digital information effectively while honing critical judgment in problem-solving. These interrelated competencies strengthen the learning process, with a focus on problem-solving and in-depth analysis within the PBL framework. **Novelty**: This study evaluates the role of PBL in enhancing critical thinking via digital literacy in Society 4.0. It underlines the significance of technology in learning, evidencing its benefit to critical thinking, and offers recommendations for educators to utilize PBL and digital literacy to unlock student's potential.

INTRODUCTION

Education is essential to life because it equips one with the ability to interpret things in real-life scenarios and must align with current developments. This aligns with Ki Hajar Dewantara's philosophical thoughts regarding education, which state that education should follow the nature of the student's era. In light of the current circumstances, globalization and the speed at which technology is developing have caused times to change more and more. In this instance, education has to accompany every ever-changing stage of life, including the utilization of technology innovation within the classroom.

The educational system is required to develop students in the digital age who are proficient with information and technology and can locate, organize, and communicate information (Natalia & Sukraini, 2021). The statement suggests that to get information, one must possess digital literacy skills, which are necessary to keep up with the explosion of online knowledge. Digital literacy includes searching for and selecting information, thinking critically, being creative, collaborating with others, communicating clearly, and being aware of computer security and changing social conditions. It involves more than just being able to operate digital devices (Naufal, 2021). There are four digital literacy competencies, according to Gilster, namely Internet Searching, Hypertextual Navigation, Content Evaluation, and

Knowledge Assembly (Hasliyah, 2022). Facts in the field show that student's high activity in the digital world does not guarantee their skills to understand digital media content. This aligns with research conducted by Hasliyah (2022), which demonstrates that students' skills to analyze information content are sufficient, with an average score of 62.41. When compared to other competencies, this one gets the lowest average score. This is also consistent with survey responses, which indicate that student's skills in compiling data for assignments still need to be enhanced. Most students also expressed difficulty in determining keywords or search terms when searching for material on the Internet. According to Cahyani et al. (2024), digital literacy skills as thinking development refer to a person's ability to use digital technology that builds cognitive awareness to think critically and analytically in managing information.

Critical thinking is a must for students to succeed in today's complicated and ever-changing world. Several developed countries have developed education systems that can hone and train students' critical thinking skills to grow well (OECD, 2018 in Astari & Sumarni, 2020). Critical thinking includes evaluating arguments, analyzing data, and drawing logical conclusions. Consequently, the learning process requires the development of critical thinking skills. Putra and Sudarti (2015) and Ramdani et al. (2020) explain that the capacity for critical thinking enables one to assess or investigate the assumptions, logic, and supporting information behind other people's ideas. Fristadi & Bharata (2015) offers six critical thinking indicators, which are as follows: (1) identifying problems, (2) collecting various relevant information, (3) compiling several alternative problem solutions, (4) making conclusions, (5) expressing opinions, and (6) evaluating arguments.

Empirical data suggests that most students must improve their critical thinking skills. Research by Maslakhatunni'mah and Agnafia (2019) demonstrates that class VII students at MTs Al Hidayah Karanggupito Ngawi still have low exam scores for critical thinking skills, indicating the need for improvement. Similarly, Nuryanti et al. (2018) reported that 1st Junoir High School Delanggu, Klaten Regency students have comparatively inadequate critical thinking skills. Teacher dominance in science learning hinders students' critical thinking skills. Critical thinking skills in students need to be emphasized, as learning is often more about memorization than cognitive development (Jaya, 2021). This affects students' urge to communicate ideas more forcefully, analyze things less thoroughly, and rely more on other people than themselves when making decisions.

Teachers must be aware of the learning design that will be implemented to meet the necessary skill goals, considering the issues and contributing elements that have been previously discussed. Teachers need to be able to blend integrated learning models with information technology advancements to teach students digital literacy and enhance their critical thinking skills. Masrinah et al. (2019) define the PBL model as a medium for developing critical thinking in students. PBL can enhance critical thinking skills since it centers on real-world issues. In addition to understanding a problem, students must also be able to collaborate to find a solution.

Based on the background review, this study aims to answer the question, "How effective is the PBL learning model optimized with digital literacy skills on student's critical thinking skills?" which is expected to contribute to the understanding of the use of technology and innovative learning approaches to increase the potential of students in this digital era. This study offers novelty by evaluating the role of PBL in improving critical thinking skills through optimizing digital literacy in students. What

distinguishes it from previous studies is that it focuses on the conventional application of PBL. In contrast, this study explicitly emphasizes the importance of technology and digital literacy as supporting elements in the learning process. Through technology integration, this study proves how digital literacy facilitates information access and supports students' critical thinking and problem-solving skills.

RESEARCH METHOD

This study is Classroom Action Research, which examines activities deliberately created and occurred in a class. This research involves four activities executed in three cycles. There are four main activities in each Cycle, namely 1) planning, 2) action, 3) observation, and 4) reflection, which are depicted in Figure 1.

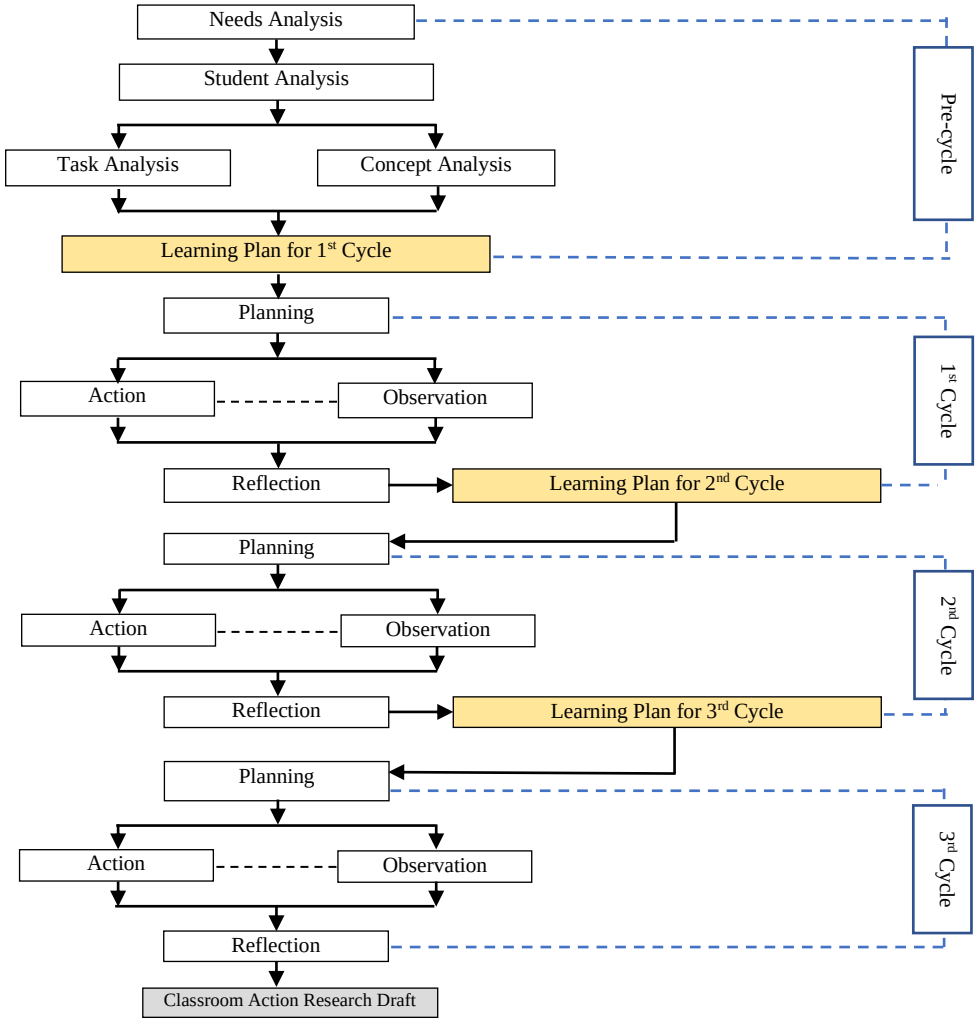

Figure 1. Diagram of classroom action research in 3 cycles.

Sample

The research involved 33 7th-grade Junior High School 2 Krian students in the 2023/2024 academic year, including 13 males and 20 females.

Instrument and Procedures

The data collection process focuses on the effectiveness of PBL learning by optimizing digital literacy, as reviewed by students' digital literacy and critical thinking skills. The instruments used are tests and questionnaires. The questionnaire uses a 1-4 Likert scale

to assess students' digital literacy skills against ability indicators. The N-Gain method is then used to calculate the increase in these skills individually and by indicator.

Meanwhile, data on student's critical thinking skills before, during, and after the study, individually and in terms of each critical thinking indicator, are collected using a test instrument. The N-Gain method calculates the increase in critical thinking skills individually and by indicator, while the Pearson correlation test assesses the relationship between digital literacy and critical thinking skills.

RESULTS AND DISCUSSION

Results

The research findings include data from tests of students' critical thinking skills and digital literacy. Information on the outcomes of digital literacy and critical thinking skills is shown.

1) Digital Literacy Skills

   The data from the student's digital literacy questionnaire was obtained through a questionnaire. Table 1 displays the findings from the initial and comprehensive data analysis of digital literacy skills.

Table 1. Descriptive analysis data of student's digital literacy skills.

	N	Minimum	Maximum	Mean	Std. Deviation
Initial Digital Literacy	33	53	75	63.76	5.19
Final Digital Literacy	33	70	85	80.55	4.80
Valid N (listwise)	33				

Additionally, statistical normality tests and paired t-tests were used to demonstrate how PBL combined with digital literacy optimization can raise student's proficiency in this area. Because there were fewer than 50 samples in this study, the Shapiro-Wilk test was utilized for the normality test. Table 2 displays the initial and final digital literacy data normality test findings.

Table 2. Normality test data of student's digital literacy skills.

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Initial Digital Literacy	0.140	33	0.100	0.967	33	0.41
Final Digital Literacy	0.316	33	0.000	0.797	33	0.00

a. Lilliefors Significance Correction

The final digital literacy data has a sig. Value (2-tailed) < 0.05 indicates that the results of student's digital literacy skills are not regularly distributed based on the data shown in Table 2. The non-parametric Wilcoxon test can be used to continue with data that is not regularly distributed. Table 3 displays the findings of the non-parametric Wilcoxon test on the initial and final digital literacy data.

Table 3. Wilcoxon non-parametric test data on students' digital literacy skills.

	Final Digital Literacy - Initial Digital Literacy
Z	-5.01[b]
Asymp. Sig. (2-tailed)	0.00

The Wilcoxon test results indicate a significance of 0.00 ($p < 0.05$), leading to the acceptance of H_1, as shown in Table 3. Thus, differences exist between student's initial and final levels of digital literacy. The average normalized gain (N-Gain) can be used to determine the size of this difference. The results of increasing student's digital literacy skills are shown in Table 4.

Table 4. Data on increasing student's digital literacy skills.

Average of Initial Digital Literacy	Average of Final Digital Literacy	Average of N-Gain	Category
64	81	0.450	Medium

According to Table 4's N-Gain analysis results, students' digital literacy skills increased by 0.45 points in the medium category. The outcomes of improving students' digital literacy were also examined for each indicator in the digital literacy skills questionnaire. Table 5 presents the findings from the examination of students' digital literacy skills for each indicator obtained from the questionnaire.

Table 5. Data on the results of increasing digital literacy indicators.

Digital Literacy Indicators	Initial	Final	N-Gain	Category
Internet Searching	68	78	0.31	Medium
Hypertextual Navigation	55	79	0.53	Medium
Content Evaluation	64	80	0.44	Medium
Knowledge Assembly	62	88	0.68	Medium
Average			0.41	Medium

Based on Table 5, the average value for increasing the overall digital literacy indicator in the medium category is 0.41.

2) Critical Thinking Skills

Student critical thinking skills were assessed through pretests and post-tests. The following provides descriptive analysis data from the pre-cycle (pretest) and cycles 1, 2, and 3:

Table 6. Descriptive analysis data of student's critical thinking skills.

	N	Minimum	Maximum	Mean	Std. Deviation
Pre-cycle	33	60	82	67.15	6.87
1st Cycle	33	62	84	75.88	6.16
2nd Cycle	33	66	92	82.06	6.03
3rd Cycle	33	73	100	92.55	8.40
Valid N (listwise)	33				

Additionally, statistical normality tests and paired t-tests were used to demonstrate how PBL combined with the optimization of applied digital literacy contributes to student's increased critical thinking skills. Table 7 displays the results of the critical thinking data normality test.

Table 7. Normality test data for student's critical thinking skills.

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Pre-cycle	0.26	33	0.000	0.835	33	0.000
1st Cycle	0.21	33	0.001	0.878	33	0.001
2nd Cycle	0.25	33	0.000	0.905	33	0.007
3rd Cycle	0.26	33	0.000	0.795	33	0.000

a. Lilliefors Significance Correction

The data resulting from students' critical thinking skills are generally not distributed based on the information shown in Table 7 because they have sig. (2-tailed) < 0.05. As a result, the Friedman test must be used in a non-parametric statistical test. Table 8 displays the results of the Friedman non-parametric assessment of student's critical thinking skills.

Table 8. Friedman test data on student's critical thinking skills.

Test Statistics	
N	33.00
Chi-Square	85.28
df	3.00
Asymp. Sig.	0.00

a. Friedman Test

Considering the information in Table 8, the Friedman test findings about students' critical thinking abilities are known to have a sig. (2-tailed) of 0.00 or less than 0.05, which means that H_1 is accepted. Thus, there are variations between the 3rd and pre-cycle student outcomes for critical thinking. One may determine the difference's magnitude by utilizing the average normalized gain, or N-Gain, and enhancing the student's critical thinking skills produced in Table 9.

Table 9. Data on increasing student's critical thinking skills.

Pretest Average	Post-test Average	N-Gain Average	Category
66	94	0.76	High

Based on the results of the N-Gain analysis in Table 9, the students experienced an increase in critical thinking skills of 0.76 in the high category. Figure 2 presents the distribution of critical thinking skills scores in each indicator in the pre-cycle, 1st Cycle, 2nd Cycle, and 3rd Cycle.

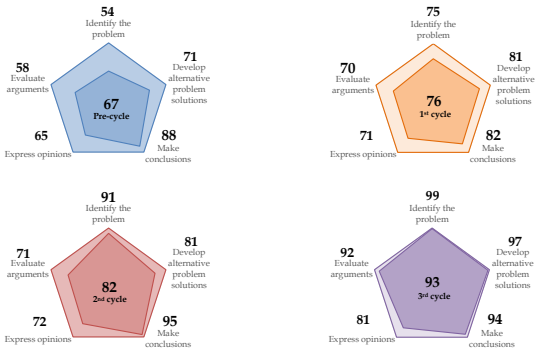

Figure 2. Distribution of critical thinking skills values for each indicator.

The results of improving students' critical thinking skills were also analyzed for each indicator. The analysis results are displayed in Table 10.

Table 10. Data on the results of improving critical thinking indicators.

Critical Thinking Indicators	Pretest	Post-test	N-Gain	Category
Identify the problem	54	99	0.98	High
Develop alternative problem solutions	71	97	0.90	High
Make conclusions	88	94	0.50	Medium
Express opinions	65	81	0.46	Medium
Evaluate arguments	58	92	0.81	High
Average			0.73	High

Table 10 shows that the indicator of improving critical thinking skills averages 0.73 in the high category. Subsequently, a Pearson correlation analysis was performed to determine the correlation between two variables: the student's critical thinking and digital literacy skills. Table 11 was gathered from the Pearson correlation test between critical thinking and digital literacy skills.

Table 11. Correlation test results of digital literacy with critical thinking.

		Digital Literacy	Critical Thinking
Digital Literacy	Pearson Correlation	1.00	0.98**
	Sig. (2-tailed)		0.00
	N	33.00	33.00
Critical Thinking	Pearson Correlation	0.98**	1.00
	Sig. (2-tailed)	0.00	
	N	33.00	33.00

**. Correlation is significant at the 0.01 level (2-tailed).

Table 11 indicates that the value of sig (2-tailed) is 0.00. Because the 2-tailed sig value is less than 0.05, there is a correlation between the student's critical thinking skills and digital literacy. Furthermore, the strong correlation category of the Pearson Correlation displays a value of 0.98.

Discussion

In this research, pre-cycle results show that even though all students have cell phones and are proficient in using the devices, their skills to process information still need to improve. As a result, they have low critical thinking skills. The findings reveal a gap between technological intelligence and practical digital literacy skills. It indicates that although the students can access information quickly, they still need to gain the skills to evaluate, analyze, and use it critically. The solution and learning design implemented for 1st Cycle is to optimize digital literacy skills in PBL. Some issues from articles or videos and learning resources packaged in barcodes are presented in the student worksheets. The students must analyze and find solutions for the issues with the help of the online learning resources provided.

The success achieved after 1st Cycle was that only some students showed increased participation while others were still passive. In addition, their critical thinking skills had yet to emerge. Some factors causing the lack of participation are (1) students are not accustomed to following PBL steps, (2) students are not accustomed to using barcodes to access information, (3) students are not accustomed to processing information obtained from the Internet, and (4) only some students are involved in the discussion groups.

The solutions and learning designs implemented for 2nd Cycle were to provide a task distribution column on the student worksheet; deepen the digital literacy approach in the student worksheet, such as writing down the link or website address of the learning resources provided; write the title of the online article; and write down some important information from the online learning resources. During the 2nd Cycle, students started understanding the PBL model of learning and developed their digital literacy skills. The student's skills in scanning barcodes to retrieve information sources and evaluate online content demonstrated an improvement in their digital literacy. In the second learning cycle, students must actively solve each problem by constructing new knowledge and working in groups. In line with the characteristics of constructivist learning theory, teachers only provide scaffolding to students who need assistance (Masgumelar & Mustafa, 2021; Hidayat & Dewi, 2023). The students also began to understand the learning process using the PBL model. They showed better skills in following the steps of PBL, such as identifying problems, searching for relevant information, and discussing actively to find solutions.

The solution and learning design implemented for the 3rd Cycle was to provide more complex problem material and discussion questions because students' critical thinking skills began to be trained. Besides, the teachers also offered flexibility in searching the learning resources on the Internet so that the students had more freedom in processing information and relating it to the questions on the worksheet. In addition, the teacher allows students to use specific keywords to search the Internet for information related to discussion questions in student worksheets. According to Kurnianingsih et al. (2017) and Pratiwi & Indiana (2022), this is a strategy for finding information through digital media. In the 3rd Cycle, almost all of the students performed better digital literacy and critical thinking skills than in the previous two cycles. Therefore, the treatment was stopped in the 3rd Cycle and not continued until the next. In this meeting, almost all students actively expressed their ideas and understood the material, as shown by their correct answers to the questions.

The information processing and analysis given earlier lead to the conclusion that implementing PBL with an enhancement to digital literacy significantly affects students' critical thinking skills. This is consistent with a study by Amin et al. (2020), which suggests that PBL helps students develop their critical thinking skills since it allows them to collaborate to identify solutions. The PBL focuses on topics that help students advance their knowledge, critical thinking, and inquiry skills. Students must devise short-term solutions for issues requiring bravery, reason, and problem-solving in real-life situations (Husniarti et al., 2021). This aligns with research on enhancing critical thinking skills, which showed an average gain score of 0.76 for each critical thinking indicator and an average gain score of 0.73 in the high category.

The syntax of the PBL, according to Arends in Astuti et al. (2020), is (1) problem orientation, (2) student organization, (3) research guidance, (4) result development and presentation, and (5) problem-solving analysis and evaluation. At the problem

orientation stage, train students to understand and define the problem clearly. The first stage of PBL facilitates one aspect of critical thinking indicators: identifying problems. The critical thinking indicator in identifying problems in the pre-cycle obtained the lowest value. Still, it gradually increased until the 3rd Cycle, so it experienced an increase of 0.98 in the high category. Students formulating problems involves critical and analytical thinking to process information, data, or ideas. This fundamental assumption supports creating information acceptable to reason (Cahyani et al., 2024).

Critical thinking skills are essential for students to connect several concepts and information to comprehend and solve problems (Rochim et al., 2024). At the stage of guiding the investigation, the teacher guides students to collect information related to the problem (Agustina et al., 2018). In the guiding investigation stage, students conduct investigations to gather relevant information. In this process, students are trained to evaluate information sources, differentiate between facts and opinions, and synthesize information from various sources, which develops their critical analysis skills. All digital literacy skills are required during the learning process, such as surfing the Internet, navigating hypertext, evaluating content, and assembling knowledge. Digital literacy skills, especially in content evaluation, involve questioning, analyzing, and evaluating the content of the information (Cahyani et al., 2024).

At the stage of developing and presenting results, teachers assist students in planning and preparing appropriate work, including helping them share their work with other students (Ardianti et al., 2022). This means that students will compile their findings into the presentation material. This involves expressing opinions to organize ideas logically, develop alternative problem solutions, and draw conclusions. Critical thinking skills are essential in assessing the reliability of information, formulating coherent arguments, and evaluating various solutions. This statement aligns with the opinion of Zakaria et al. (2019), who state that critical thinking must organize thoughts concisely and coherently. Meanwhile, digital literacy skills are needed to access, manage, and present information effectively, especially in the knowledge assembly.

Developing alternative problem solutions is an indicator of critical thinking that has experienced a significant increase from pre-cycle to 3rd Cycle. Problems in the PBL activities must be authentic problems and include missing information or unclear answers, such as case studies (Seibert, 2021). Mutual understanding can be created through discussion, communication, and interaction activities that involve conversation and building on each other's ideas. Learning resources presented using digital technology can also effectively support collaborative processes in the classroom. This aligns with the analysis of digital literacy skills in the knowledge assembly aspect, which obtained the highest average of the three other indicators.

Meanwhile, making conclusions is an indicator of critical thinking that is less stable even though it has increased from pre-cycle to 3rd Cycle. Because the students do not understand the discussed topic, they struggle to integrate the information obtained and filter the most relevant information to make conclusions. Another factor is that the students have not become accustomed to a structured and systematic discussion format, so they need the teacher to direct them in making clear and focused conclusions. Although learning with a new paradigm requires students to reconstruct their own learning experiences, the role of the teacher is still needed as a facilitator so that students maintain their way (Juraidah & Hartoyo, 2022).

Critical thinking appears by evaluating arguments, and this skill significantly increased from the pre-cycle to the 3rd Cycle. Critical thinking skills were strong, as

evidenced by a 0.81 increase in the high category and most students providing correct opinions and reasons. Therefore, it indicates that the students can reflect and re-evaluate the decisions or solutions and consider alternative solutions. Fahmi et al. (2019) and Putri et al. (2021) stated that students can be said to think critically if they can provide rational arguments for a problem.

PBL learning encourages students to work together actively to solve complex problems creatively. It is based on John Dewey's teaching theory, where teachers guide students in projects to solve real-world issues (Mastuti, 2024). This method aids students in cultivating critical thinking abilities essential for tackling social and intellectual issues in the real world. Piaget's theory about how children develop their thinking says that children go through different stages, affecting their learning (Magdalena et al., 2023). This theory is closely connected to PBL, which uses digital tools. In PBL, students work on real problems, which helps them develop thinking skills. Using digital tools enriches this process by giving students access to information and collaboration, which speeds up their development and improves their thinking skills. According to Vygotsky's socio-constructivist learning theory, children can develop better concepts through dialogue with those around them (Saputro & Pakpahan, 2021). Integrating digital literacy into PBL allows students to access comprehensive information sources and communication tools to support effective dialogue and collaboration.

Based on the explanation above, digital literacy and critical thinking skills are closely correlated because both are essential components in PBL. This is verified by a Pearson correlation analysis, which indicates a positive and robust relationship. It means that the more optimal student's digital literacy skills are, the better their critical thinking skills will be. The correlation test results are relevant to Nurviana et al. (2024), stating that digital literacy and critical thinking skills are two interrelated entities. Digital literacy provides individuals the technological knowledge and instruments to access, validate, and utilize information. In contrast, by having critical thinking skills, an individual can generate a conceptual framework for analyzing and assessing that information.

According to Mufidah et al. (2023), digital literacy is an essential skill that should be developed early in school because it is indispensable for 21st-century students. As technology rapidly progresses, the need for proficiency in using digital tools and platforms for learning is growing. This assists students in effectively using technology in education and prepares them to address challenges in a workplace that is increasingly integrated with technology. However, amidst the progress of technology and its ease of access, a significant challenge exists in sifting through inaccurate or misleading information. Hence, critical thinking skills are essential in the era of globalization. By thinking critically, students can more rationally and maturely filter information, enabling them to make informed decisions (Azura et al., 2023). This ability safeguards them from being readily influenced by unverified information and encourages them to seek evidence before accepting or believing anything consistently.

Digital literacy involves effectively searching, evaluating, and using information from digital sources, forming the basis of critical analysis (Restianty, 2018). Meanwhile, Gonzalez-Mohino et al. (2023) added that critical thinking skills help assess the relevance of information obtained digitally and enable them to make informed decisions. In the context of PBL, when students develop their digital literacy, they actively practice critical thinking skills through problem-solving, evaluation, and

reflection. Digital literacy involves finding and evaluating accurate and credible sources of information to assess various options and determine the best solution. Meanwhile, critical thinking allows students to synthesize this information into a coherent and comprehensive understanding and integrate multiple perspectives and data into valid conclusions.

The research results show that applying the PBL model optimized with digital literacy significantly improves students' critical thinking skills. In this research, the PBL model provides access and direction to use various digital platforms to search for, evaluate, and synthesize information relevant to the problems in the student worksheet. This means that literacy skills, an essential essence of digital literacy, are very influential in this process because students need critical skills to assess the quality and relevance of the information found to the problems faced. This skill makes learning student-centered. Information literacy skills also train thinking and analytical skills toward problems (Salsabila et al., 2024).

At the same time, digital literacy provides tools and platforms that allow people to access information. PBL digital worksheets guide students toward problem-solving and enhance their digital literacy (Distrik et al., 2024). These findings support the argument that technology integration in PBL can train critical thinking skills through better access to information and evaluative skills, aligning with the digital era's demands. In conclusion, this research confirms that the combination of PBL and digital literacy is highly effective in fostering stronger critical thinking skills among students.

CONCLUSION

Fundamental finding: Student's critical thinking skills in the high category after participating in PBL by improving their digital literacy skills. Digital literacy and critical thinking skills are closely correlated with a Pearson correlation in the strong correlation category because both are essential components in PBL. **Implication:** The better a student's digital literacy skills are, the higher their critical thinking skills are, and both support each other in the context of PBL. Digital literacy involves effectively searching for, evaluating, and using information from various digital sources. In the PBL context, good digital literacy allows students to access relevant information, criticize its validity, and use it to support problem-solving. **Limitation:** This study was limited to only three cycles within a specific period and only involved 33 7th-grade junior high school students from one school. Therefore, the findings may not generalize to a broader population or different education levels. **Future research:** It is suggested that there will be a case study on the implementation of PBL which focuses on digital literacy only, such as exploring how good integration of digital literacy can improve student's skills to identify, evaluate, and use digital information critically in the context of solving real problems.

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REFERENCES

Agustina, K., Kristiyanto, W. H., & Noviandini, D. (2018). The analysis of lesson plan based on syntax and content problems in accordance with the rule model of problem-based learning. *Unnes Science Education Journal, 7*(1), 50–60. https://doi.org/10.15294/usej.v7i1.14067

Amin, S., Utaya, S., Bachri, S., Sumarmi, & Susilo, S. (2020). Effect of problem-based learning on critical thinking skills and environmental attitude. *Journal for the Education of Gifted Young Scientists, 8*(2), 743–755. https://doi.org/10.17478/jegys.650344

Ardianti, R., Sujarwanto, E., & Surahman, E. (2022). Problem-based learning: Apa dan bagaimana. *Diffraction: Journal for Physics Education and Applied Physics, 3*(1), 27–35. https://doi.org/10.37058/diffraction.v3i1.4416

Astari, J. I. R., & Sumarni, W. (2020). Pengembangan lembar kerja peserta didik bermuatan etnosains guna meningkatkan kemampuan berpikir kritis. *Journal of Chemistry in Education, 9*(2), 1–9.

Astuti, R., Mardiyana, & Triyanto. (2020). Analysis of the problem-based learning syntax in vocational mathematics books on matrix material. *International Journal of Multicultural and Multireligious Understanding, 7*(1), 704–710. https://doi.org/10.18415/ijmmu.v7i1.1382

Azura, A. R., Suryanti, S., & Hariyono, E. (2023). Science teaching materials based on field trips with local wisdom to improve elementary school students' critical thinking. *International Journal of Current Educational Research, 2*(2), 115–127. https://doi.org/10.53621/ijocer.v2i2.240

Cahyani, N., Hutagalung, E. N. H., & Harahap, S. H. (2024). Berpikir kritis melalui membaca: Pentingnya literasi dalam era digital. *IJEDR: Indonesian Journal of Education and Development Research, 2*(1), 417–422. https://doi.org/10.57235/ijedr.v2i1.1795

Distrik, I. W., Ertikanto, C., Purwati, Y. S., Saregar, A., & Ab Rahman, N. F. (2024). Digital problem-based worksheet with 3D pageflip: An effort to address conceptual understanding problems and enhance digital literacy skills. *Jurnal Pendidikan IPA Indonesia, 13*(1), 116–127. https://doi.org/10.15294/jpii.v13i1.48604

Fahmi, F., Setiadi, I., Elmawati, D., & Sunardi, S. (2019). Discovery learning method for training critical thinking skills of students. *European Journal of Education Studies, 6*(3), 342–351. https://doi.org/10.5281/zenodo.3345924

Gonzalez-Mohino, M., Rodriguez-Domenech, M. Á., Callejas-Albiñana, A. I., & Castillo-Canalejo, A. (2023). Empowering critical thinking: The role of digital tools in citizen participation. *Journal of New Approaches in Educational Research, 12*(2), 258–275. https://doi.org/10.7821/naer.2023.7.1385

Hasliyah, S., Sofyan, A., & Fadilah, E. (2022). Kompetensi literasi digital peserta didik pada mata pelajaran biologi. *Attractive: Innovative Education Journal, 4*(2), 156–167. https://doi.org/10.51278/aj.v4i2.420

Hidayat, T., & Dewi (Nino Adhi), N. R. (2023). Kajian teori: Pengembangan bahan ajar aljabar berorientasi model pembelajaran preprospect berbantuan Heyzine flipbooks bernuansa STEM untuk meningkatkan kemampuan pemecahan masalah matematis. *PRISMA, Prosiding Seminar Nasional Matematika, 4*, 235–243.

Husniarti, D., Hadiati, S., & Angraeni, L. (2024). Pengembangan modul elektronik berbasis problem-based learning (PBL) pada praktikum IPA materi listrik statis dalam kehidupan sehari-hari. *Jurnal Inovasi Pendidikan Sains (JIPS), 3*(2), 76–85. https://doi.org/10.37729/jips.v3i2.1689

Jaya, I. K. M. A. (2021). Peran guru IPS meningkatkan kemampuan berpikir kritis siswa melalui metode pembelajaran inkuiri. *Sang Acharya: Jurnal Profesi Guru, 2*(1), 22–33.

Juraidah, J., & Hartoyo, A. (2022). Peran guru dalam menumbuhkembangkan kemandirian belajar dan kemampuan berpikir kritis siswa sekolah dasar melalui proyek penguatan profil pelajar pancasila. *Jurnal Pendidikan Dasar Perkhasa: Jurnal Penelitian Pendidikan Dasar, 8*(2), 105–118. https://doi.org/10.31932/jpdp.v8i2.1719

Kurnianingsih, I., Rosini, R., & Ismayati, N. (2017). Upaya peningkatan kemampuan literasi digital bagi tenaga perpustakaan sekolah dan guru di wilayah Jakarta Pusat melalui pelatihan literasi informasi. *Jurnal Pengabdian Kepada Masyarakat (Indonesian Journal of Community Engagement), 3*(1), 61. https://doi.org/10.22146/jpkm.25370

Magdalena, I., Nurchayati, A., Suhirman, D. P., & Fathya, N. N. (2023). Implementasi teori pengembangan kognitif Jean Piaget dalam pembelajaran IPA di sekolah dasar. *Anwarul: Jurnal Pendidikan dan Dakwah, 3*(5), 960–969. https://doi.org/10.58578/anwarul.v3i5.1431

Masgumelar, N. K., & Mustafa, P. S. (2021). Teori belajar konstruktivisme dan implikasinya dalam pendidikan. *GHAITSA: Islamic Education Journal, 2*(1), 49–57. https://doi.org/10.62159/ghaitsa.v2i1.188

Maslakhatunni'mah, D., Safitri, L. B., & Agnafia, D. N. (2019). Analisis kemampuan berpikir kritis pada mata pelajaran IPA siswa kelas VII SMP. *Seminar Nasional Pendidikan Sains*, 179-185.

Masrinah, E. N., Aripin, I., & Gaffar, A. A. (2019). Problem based learning (PBL) untuk meningkatkan keterampilan berpikir kritis. *Prosiding Seminar Nasional Pendidikan*, 924-932.

Mastuti, I. F. N. M. (2024). Literature review: Pembelajaran berbasis problem-based learning sebagai realisasi kurikulum merdeka dalam meningkatkan kemampuan peserta didik. *Prosiding Seminar Nasional Pendidikan IPA*, 43-47.

Mufidah, A., Indana, S., & Arifin, I. S. Z. (2023). E-module based on blended learning type flipped classroom on climate change materials to train students' digital literacy ability. *International Journal of Current Educational Research, 2*(1), 1–16. https://doi.org/10.53621/ijocer.v2i1.204

Natalia, K., & Sukraini, N. (2021). Pendekatan konsep merdeka belajar dalam pendidikan era digital. *Prosiding Seminar Nasional IAHN-TP Palangka Raya*, 22–34.

Naufal, H. A. (2021). Literasi digital. *Perspektif, 1*(2), 195–202. https://doi.org/10.53947/perspekt.v1i2.32

Nurviana, S., Ardhia, N., Putri, P., & Rachman, I. F. (2024). Hubungan antara literasi digital dan kemampuan berpikir kritis dalam membaca berita online. *Cendikia: Jurnal Pendidikan dan Pengajaran, 2*(5), 391–398. https://doi.org/10.572349/cendikia.v2i5.1570

Nuryanti, L., Zubaidah, S., & Diantoro, M. (2018). Analisis kemampuan berpikir kritis siswa SMP. *Jurnal Pendidikan: Teori, Penelitian, dan Pengembangan, 3*(2), 155–158. http://dx.doi.org/10.17977/jptpp.v3i2.10490

OECD. (2018). *PISA 2012 results in focus: What 15-year-olds know and what they can do with what they know*. Columbia University.

Pratiwi, M. K., & Indana, S. (2022). Pengembangan e-modul berbasis QR-Code untuk melatihkan kemampuan literasi digital siswa pada materi perubahan lingkungan. *Berkala Ilmiah Pendidikan Biologi (BioEdu), 11*(2), 457–468. https://doi.org/10.26740/bioedu.v11n2.p457-468

Putra, P. D. A., & Sudarti. (2015). Pengembangan sistem e-learning untuk meningkatkan keterampilan berpikir kritis mahasiswa pendidikan fisika. *Jurnal Fisika Indonesia, 19*(55), 45–48. https://doi.org/10.22146/jfi.24373

Putri, M. H., Fahmi, F., & Wahyuningsih, E. (2021). Efektivitas perangkat pembelajaran IPA untuk melatihkan keterampilan berpikir kritis peserta didik SMP pada materi pokok listrik statis. *Journal of Banua Science Education, 1*(2), 79–84.

Ramdani, A., Jufri, A. W., & Setiadi, D. (2020). Kemampuan berpikir kritis dan penguasaan konsep dasar IPA peserta didik. *Jurnal Penelitian Pendidikan IPA, 6*(1), 119–124. https://doi.org/10.29303/jppipa.v6i1.388

Restianty, A. (2018). Literasi digital, sebuah tantangan baru dalam literasi media. *Gunahumas: Jurnal Kehumasan Universitas Pendidikan Indonesia, 1*(1), 72–87. https://doi.org/10.17509/ghm.v1i1.28380

Rochim, R. A., Af, N., & Wulandari, D. (2024). Description of students' critical thinking skills after implementing the problem posing model assisted by PheT in distance learning.

IJORER: International Journal of Recent Educational Research, 5(3), 690–701. https://doi.org/10.46245/ijorer.v5i3.601

Salsabila, A., Hidayati, S. N., & Aulia, E. V. (2024). Analisis kemampuan literasi informasi siswa SMP dalam menghadapi pembelajaran di era Society 5.0. *Nusantara: Jurnal Pendidikan Indonesia, 4*(2), 570–580.

Saputro, M. N. A., & Pakpahan, P. L. (2021). Mengukur keefektifan teori konstruktivisme dalam pembelajaran. *Journal of Education and Instruction (JOEAI), 4*(1), 24–39. https://doi.org/10.31539/joeai.v4i1.2151

Seibert, S. A. (2021). Problem-based learning: A strategy to foster Generation Z's critical thinking and perseverance. *Teaching and Learning in Nursing, 16*(1), 85–88. https://doi.org/10.1016/j.teln.2020.09.002

Zakaria, I., Suyono, & Tri Priyatni, E. (2019). Dimensi berpikir kritis. *Jurnal Pendidikan: Teori, Penelitian, dan Pengembangan, 6*(10), 1630–1649. http://dx.doi.org/10.17977/jptpp.v6i10.15072

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